Sweetness

```
Sweetness.A
<-c(3,8,8,7,8,7,6,7,5,6,8,4,7,7,6,8,6,9,7,7,7,7,8,9,7,4,7,8,6,2,8,8,7,2,9,6,2,8,9,9,9,8,6,8,7,8,8,8,8,8,
7,6,7,7,9,9)
Sweetness.B
<-c(3,8,9,7,8,7,8,6,8,7,7,4,7,7,7,5,6,7,7,7,7,5,8,9,7,8,8,6,6,4,8,9,8,3,8,7,2,8,8,9,8,7,6,8,6,9,9,9,7,8,
7,4,7,6,8,3)
Sweetness.C
<-c(4,5,6,4,7,3,4,4,4,6,6,8,6,3,8,2,6,1,4,5,5,8,8,3,7,6,3,4,2,6,8,5,3,6,3,5,2,6,6,8,6,7,7,7,3,6,4,2,7,5,
6,5,4,7,7,7)
Sweetness.D
<-c(8,4,7,3,7,4,5,3,4,6,6,8,8,4,8,8,7,4,8,7,6,8,6,7,8,6,4,4,3,8,8,4,2,8,5,3,5,6,7,9,7,4,7,7,5,6,4,3,5,7,
6,3,7,8,4,8)
Attribute <- c(Sweetness.A,Sweetness.B,Sweetness.C,Sweetness.D)
> Sweetness.A <- rep("A", times=56)
> Sweetness.B <- rep("B", times=56)
> Sweetness.C <- rep("C", times=56)
> Sweetness.D <- rep("D", times=56)
> Sweetness<- factor(c(Sweetness.A,Sweetness.B,Sweetness.C,Sweetness.D))
> Assessors <- factor(rep(c(1:56), times=4))
> results <-
data.frame(Sweetness=factor(Sweetness),Assessors=factor(Assessors),Attribute=Attribute)
> results
```

	Sweetness	Assessors	Attribute
1	A	1	3
2	A	2	8
3	A	3	8
4	A	4	7
5	A	5	8
6	A	6	7
7	A	7	6
8	A	8	7
9	A	9	5
10	A	10	6
11	A	11	8
12	A	12	4
13	A	13	7
14	A	14	7
15	A	15	6
16	A	16	8
17	A	17	6
18	A	18	9
19	A	19	7

20	A	20	7
21	A	21	7
22	A	22	7
23	A	23	8
24	A	24	9
25	A	25	7
26	A	26	4
27	A	27	7
28	A	28	8
29	A	29	6
30	A	30	2
31	A	31	8
32	A	32	8
33	A	33	7
34	A	34	2
35	A	35	9
36	A	36	6
37	A	37	2
38	A	38	8
39	A	39	9
40	A	40	9
41	A	41	9
42	A	42	8
43	A	43	6
44	A	44	8
45	A	45	7
46	A	46	8
47	A	47	8
48	A	48	8
49	A	49	8
50	A	50	8
51	A	51	7
52	A	52	6
53	A	53	7
54	A	54	7
55	A	55	9
56	A	56	9
57	B	1	3
58	B	2	8
59	B	3	9
60	B	4	7
61	B	5	8
62	B	6	7
63	B	7	8

64	B	8	6
65	B	9	8
66	B	10	7
67	B	11	7
68	B	12	4
69	B	13	7
70	B	14	7
71	B	15	7
72	B	16	5
73	B	17	6
74	B	18	7
75	B	19	7
76	B	20	7
77	B	21	7
78	B	22	5
79	B	23	8
80	B	24	9
81	B	25	7
82	B	26	8
83	B	27	8
84	B	28	6
85	B	29	6
86	B	30	4
87	B	31	8
88	B	32	9
89	B	33	8
90	B	34	3
91	B	35	8
92	B	36	7
93	B	37	2
94	B	38	8
95	B	39	8
96	B	40	9
97	B	41	8
98	B	42	7
99	B	43	6
100	B	44	8
101	B	45	6
102	B	46	9
103	B	47	9
104	B	48	9
105	B	49	7
106	B	50	8
107	B	51	7

108	B	52	4
109	B	53	7
110	B	54	6
111	B	55	8
112	B	56	3
113	C	1	4
114	C	2	5
115	C	3	6
116	C	4	4
117	C	5	7
118	C	6	3
119	C	7	4
120	C	8	4
121	C	9	4
122	C	10	6
123	C	11	6
124	C	12	8
125	C	13	6
126	C	14	3
127	C	15	8
128	C	16	2
129	C	17	6
130	C	18	1
131	C	19	4
132	C	20	5
133	C	21	5
134	C	22	8
135	C	23	8
136	C	24	3
137	C	25	7
138	C	26	6
139	C	27	3
140	C	28	4
141	C	29	2
142	C	30	6
143	C	31	8
144	C	32	5
145	C	33	3
146	C	34	6
147	C	35	3
148	C	36	5
149	C	37	2
150	C	38	6
151	C	39	6

152	C	40	8
153	C	41	6
154	C	42	7
155	C	43	7
156	C	44	7
157	C	45	3
158	C	46	6
159	C	47	4
160	C	48	2
161	C	49	7
162	C	50	5
163	C	51	6
164	C	52	5
165	C	53	4
166	C	54	7
167	C	55	7
168	C	56	7
169	D	1	8
170	D	2	4
171	D	3	7
172	D	4	3
173	D	5	7
174	D	6	4
175	D	7	5
176	D	8	3
177	D	9	4
178	D	10	6
179	D	11	6
180	D	12	8
181	D	13	8
182	D	14	4
183	D	15	8
184	D	16	8
185	D	17	7
186	D	18	4
187	D	19	8
188	D	20	7
189	D	21	6
190	D	22	8
191	D	23	6
192	D	24	7
193	D	25	8
194	D	26	6
195	D	27	4

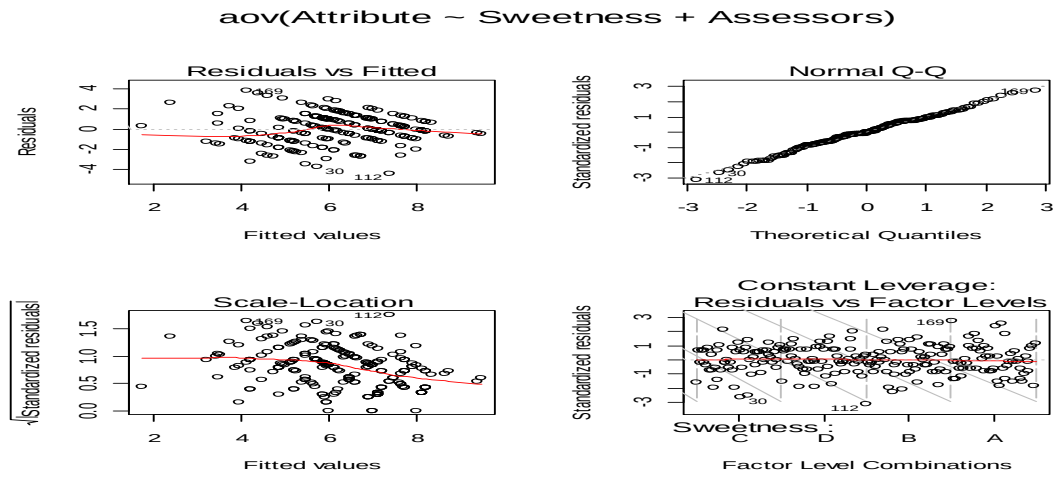
196	D	28	4
197	D	29	3
198	D	30	8
199	D	31	8
200	D	32	4
201	D	33	2
202	D	34	8
203	D	35	5
204	D	36	3
205	D	37	5
206	D	38	6
207	D	39	7
208	D	40	9
209	D	41	7
210	D	42	4
211	D	43	7
212	D	44	7
213	D	45	5
214	D	46	6
215	D	47	4
216	D	48	3
217	D	49	5
218	D	50	7
219	D	51	6
220	D	52	3
221	D	53	7
222	D	54	8
223	D	55	4
224	D	56	8

```
> library(asbio)
> tukey.add.test(results$Attribute,results$Sweetness,results$Assessors)

        Tukey's one df test for additivity

data:  results$Sweetness and results$Assessors on  results$Attribute
F = 0.5067, num.df = 1, denom.df = 164, p-value = 0.4776
preference.aov <- aov(Attribute~Sweetness+Assessors,results)
summary(preference.aov)
             Df Sum Sq Mean Sq F value     Pr(>F)
Sweetness     3 123.89  41.298 15.2575 8.278e-09 ***
Assessors    55 261.21   4.749  1.7547   0.003531 **
Residuals   165 446.61   2.707
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
oldpar <- par(oma=c(0,0,3,0), mfrow=c(2,2))
plot(preference.aov)
```




```
TukeyHSD(preference.aov,"Sweetness",conf.level=0.99)
```

Tukey multiple comparisons of means

99% family-wise confidence level

Fit: aov(formula = Attribute ~ Sweetness + Assessors, data = results)

$Sweetness

	diff	lwr	upr	p adj
B-A	-0.08928571	-1.0722410	0.89366962	0.9917193
C-A	-1.78571429	-2.7686696	-0.80275896	0.0000003
D-A	-1.12500000	-2.1079553	-0.14204467	0.0022097
C-B	-1.69642857	-2.6793839	-0.71347324	0.0000010
D-B	-1.03571429	-2.0186696	-0.05275896	0.0058285
D-C	0.66071429	-0.3222410	1.64366962	0.1494558

Milkflavour

```
> Milkflavour.A
<-c(7,8,9,7,8,6,6,7,7,7,8,7,7,7,7,7,6,9,8,8,7,6,5,9,8,6,5,7,7,2,9,8,7,3,9,5,4,8,8,9,9,6,6,7,6,8,7,8,8,8,
7,6,7,4,8,7)
> Milkflavour.B
<-c(7,8,9,8,7,7,7,8,8,8,6,7,6,6,7,5,6,7,8,7,7,8,5,9,8,7,8,6,4,5,9,9,8,2,9,5,3,8,9,9,9,7,5,7,5,8,8,8,7,8,
8,7,7,4,8,7)
> Milkflavour.C
<-c(6,4,7,4,7,3,4,5,3,6,5,6,6,4,7,2,5,1,4,7,4,7,5,5,7,6,1,3,2,6,5,5,3,6,3,4,3,7,7,8,6,6,6,4,4,6,5,1,7,5,
6,4,4,3,7,3)
> Milkflavour.D
<-c(6,4,7,5,7,5,5,3,5,5,4,7,8,4,9,5,6,4,8,8,6,7,5,8,7,6,1,5,2,8,3,4,2,7,4,4,4,2,7,9,8,3,7,6,4,5,6,2,3,6,
```

```
5,6,5,5,3,8)
>
> Attribute <- c(Milkflavour.A,Milkflavour.B,Milkflavour.C,Milkflavour.D)
> Milkflavour.A <- rep("A", times=56)
> Milkflavour.B <- rep("B", times=56)
> Milkflavour.C <- rep("C", times=56)
> Milkflavour.D <- rep("D", times=56)
>
> Milkflavour<- factor(c(Milkflavour.A,Milkflavour.B,Milkflavour.C,Milkflavour.D))
> Assessors <- factor(rep(c(1:56), times=4))
> results <-
data.frame(Milkflavour=factor(Milkflavour),Assessors=factor(Assessors),Attribute=Attribute)
> results
```

	Milkflavour	Assessors	Attribute
1	A	1	7
2	A	2	8
3	A	3	9
4	A	4	7
5	A	5	8
6	A	6	6
7	A	7	6
8	A	8	7
9	A	9	7
10	A	10	7
11	A	11	8
12	A	12	7
13	A	13	7
14	A	14	7
15	A	15	7
16	A	16	7
17	A	17	6
18	A	18	9
19	A	19	8
20	A	20	8
21	A	21	7
22	A	22	6
23	A	23	5
24	A	24	9
25	A	25	8
26	A	26	6
27	A	27	5
28	A	28	7
29	A	29	7
30	A	30	2

31	A	31	9
32	A	32	8
33	A	33	7
34	A	34	3
35	A	35	9
36	A	36	5
37	A	37	4
38	A	38	8
39	A	39	8
40	A	40	9
41	A	41	9
42	A	42	6
43	A	43	6
44	A	44	7
45	A	45	6
46	A	46	8
47	A	47	7
48	A	48	8
49	A	49	8
50	A	50	8
51	A	51	7
52	A	52	6
53	A	53	7
54	A	54	4
55	A	55	8
56	A	56	7
57	B	1	7
58	B	2	8
59	B	3	9
60	B	4	8
61	B	5	7
62	B	6	7
63	B	7	7
64	B	8	8
65	B	9	8
66	B	10	8
67	B	11	6
68	B	12	7
69	B	13	6
70	B	14	6
71	B	15	7
72	B	16	5
73	B	17	6
74	B	18	7

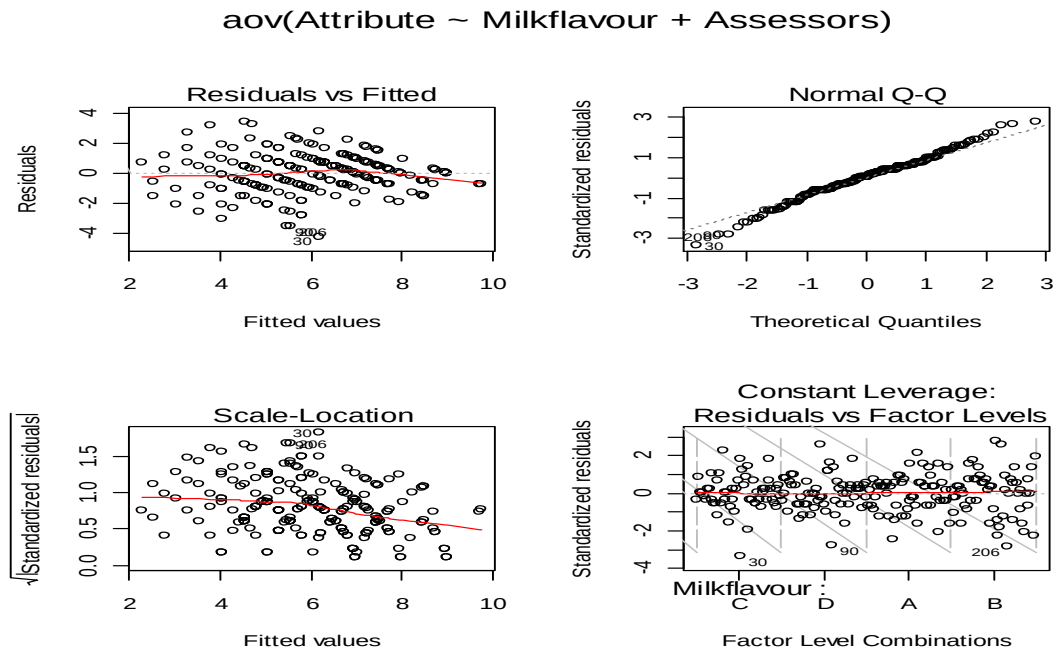
75	B	19	8
76	B	20	7
77	B	21	7
78	B	22	8
79	B	23	5
80	B	24	9
81	B	25	8
82	B	26	7
83	B	27	8
84	B	28	6
85	B	29	4
86	B	30	5
87	B	31	9
88	B	32	9
89	B	33	8
90	B	34	2
91	B	35	9
92	B	36	5
93	B	37	3
94	B	38	8
95	B	39	9
96	B	40	9
97	B	41	9
98	B	42	7
99	B	43	5
100	B	44	7
101	B	45	5
102	B	46	8
103	B	47	8
104	B	48	8
105	B	49	7
106	B	50	8
107	B	51	8
108	B	52	7
109	B	53	7
110	B	54	4
111	B	55	8
112	B	56	7
113	C	1	6
114	C	2	4
115	C	3	7
116	C	4	4
117	C	5	7
118	C	6	3

119	C	7	4
120	C	8	5
121	C	9	3
122	C	10	6
123	C	11	5
124	C	12	6
125	C	13	6
126	C	14	4
127	C	15	7
128	C	16	2
129	C	17	5
130	C	18	1
131	C	19	4
132	C	20	7
133	C	21	4
134	C	22	7
135	C	23	5
136	C	24	5
137	C	25	7
138	C	26	6
139	C	27	1
140	C	28	3
141	C	29	2
142	C	30	6
143	C	31	5
144	C	32	5
145	C	33	3
146	C	34	6
147	C	35	3
148	C	36	4
149	C	37	3
150	C	38	7
151	C	39	7
152	C	40	8
153	C	41	6
154	C	42	6
155	C	43	6
156	C	44	4
157	C	45	4
158	C	46	6
159	C	47	5
160	C	48	1
161	C	49	7
162	C	50	5

163	C	51	6
164	C	52	4
165	C	53	4
166	C	54	3
167	C	55	7
168	C	56	3
169	D	1	6
170	D	2	4
171	D	3	7
172	D	4	5
173	D	5	7
174	D	6	5
175	D	7	5
176	D	8	3
177	D	9	5
178	D	10	5
179	D	11	4
180	D	12	7
181	D	13	8
182	D	14	4
183	D	15	9
184	D	16	5
185	D	17	6
186	D	18	4
187	D	19	8
188	D	20	8
189	D	21	6
190	D	22	7
191	D	23	5
192	D	24	8
193	D	25	7
194	D	26	6
195	D	27	1
196	D	28	5
197	D	29	2
198	D	30	8
199	D	31	3
200	D	32	4
201	D	33	2
202	D	34	7
203	D	35	4
204	D	36	4
205	D	37	4
206	D	38	2

```
207             D       39          7
208             D       40          9
209             D       41          8
210             D       42          3
211             D       43          7
212             D       44          6
213             D       45          4
214             D       46          5
215             D       47          6
216             D       48          2
217             D       49          3
218             D       50          6
219             D       51          5
220             D       52          6
221             D       53          5
222             D       54          5
223             D       55          3
224             D       56          8
> library(asbio)
> tukey.add.test(results$Attribute,results$Milkflavour,results$Assessors)
        Tukey's one df test for additivity

data:  results$Milkflavour and results$Assessors on results$Attribute
F = 1.3021, num.df = 1, denom.df = 164, p-value = 0.2555
> preference.aov <- aov(Attribute~Milkflavour+Assessors,results)
> summary(preference.aov)
             Df Sum Sq Mean Sq F value     Pr(>F)
Milkflavour   3 213.44  71.147 33.4160  < 2.2e-16 ***
Assessors    55 286.03   5.201  2.4426 7.061e-06 ***
Residuals   165 351.31   2.129
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> oldpar <- par(oma=c(0,0,3,0), mfrow=c(2,2))
> plot(preference.aov)
```



TukeyHSD(preference.aov,"Sweetness",conf.level=0.99)

Tukey multiple comparisons of means

99% family-wise confidence level

Fit: aov(formula = Attribute ~ Milkflavour + Assessors, data = results)

$Milkflavour

	diff	lwr	upr	p adj
B-A	0.05357143	-0.8182248	0.9253677	0.9973923
C-A	-2.14285714	-3.0146534	-1.2710609	0.0000000
D-A	-1.64285714	-2.5146534	-0.7710609	0.0000001
C-B	-2.19642857	-3.0682248	-1.3246323	0.0000000
D-B	-1.69642857	-2.5682248	-0.8246323	0.0000000
D-C	0.50000000	-0.3717962	1.3717962	0.2708005

Fruit flavor

> Fruitflavour.A

<-c(7,9,8,6,7,7,6,8,7,7,9,7,7,7,7,8,6,8,9,8,8,8,8,8,8,7,8,8,7,1,8,8,7,3,9,7,6,8,8,9,9,8,5,7,7,8,7,7,7,8,8,8,8,6,9,6)

> Fruitflavour.B

<-c(7,9,9,8,7,7,7,7,8,8,9,7,6,6,6,7,6,6,9,7,7,7,7,9,8,8,8,6,4,4,9,9,8,3,7,8,6,9,9,9,8,6,5,8,6,8,7,8,8,8,8,8,8,5,9,5)

> Fruitflavour.C

<-c(7,6,7,4,5,1,3,8,3,4,8,6,6,5,8,3,5,1,5,4,5,6,6,2,7,7,1,3,1,6,4,5,3,7,4,5,4,3,6,8,6,6,6,8,3,6,2,1,5,5,5,4,4,7,7,3)

> Fruitflavour.D

```
<-c(8,4,7,4,7,5,5,3,4,4,7,7,8,4,8,9,7,4,7,7,7,8,6,3,8,7,2,3,2,8,6,4,2,8,6,5,5,2,8,9,7,3,8,7,6,3,4,3,3,6,
6,6,7,8,4,9)
>
> Attribute <- c(Fruitflavour.A,Fruitflavour.B,Fruitflavour.C,Fruitflavour.D)
> Fruitflavour.A <- rep("A", times=56)
> Fruitflavour.B <- rep("B", times=56)
> Fruitflavour.C <- rep("C", times=56)
> Fruitflavour.D <- rep("D", times=56)
>
> Fruitflavour<- factor(c(Fruitflavour.A,Fruitflavour.B,Fruitflavour.C,Fruitflavour.D))
> Assessors <- factor(rep(c(1:56), times=4))
>
> results <-
data.frame(Fruitflavour=factor(Fruitflavour),Assessors=factor(Assessors),Attribute=Attribute)
> results
```

	Fruitflavour	Assessors	Attribute
1	A	1	7
2	A	2	9
3	A	3	8
4	A	4	6
5	A	5	7
6	A	6	7
7	A	7	6
8	A	8	8
9	A	9	7
10	A	10	7
11	A	11	9
12	A	12	7
13	A	13	7
14	A	14	7
15	A	15	7
16	A	16	8
17	A	17	6
18	A	18	8
19	A	19	9
20	A	20	8
21	A	21	8
22	A	22	8
23	A	23	8
24	A	24	8
25	A	25	8
26	A	26	7
27	A	27	8
28	A	28	8

29	A	29	7
30	A	30	1
31	A	31	8
32	A	32	8
33	A	33	7
34	A	34	3
35	A	35	9
36	A	36	7
37	A	37	6
38	A	38	8
39	A	39	8
40	A	40	9
41	A	41	9
42	A	42	8
43	A	43	5
44	A	44	7
45	A	45	7
46	A	46	8
47	A	47	7
48	A	48	7
49	A	49	7
50	A	50	8
51	A	51	8
52	A	52	8
53	A	53	8
54	A	54	6
55	A	55	9
56	A	56	6
57	B	1	7
58	B	2	9
59	B	3	9
60	B	4	8
61	B	5	7
62	B	6	7
63	B	7	7
64	B	8	7
65	B	9	8
66	B	10	8
67	B	11	9
68	B	12	7
69	B	13	6
70	B	14	6
71	B	15	6
72	B	16	7

73	B	17	6
74	B	18	6
75	B	19	9
76	B	20	7
77	B	21	7
78	B	22	7
79	B	23	7
80	B	24	9
81	B	25	8
82	B	26	8
83	B	27	8
84	B	28	6
85	B	29	4
86	B	30	4
87	B	31	9
88	B	32	9
89	B	33	8
90	B	34	3
91	B	35	7
92	B	36	8
93	B	37	6
94	B	38	9
95	B	39	9
96	B	40	9
97	B	41	8
98	B	42	6
99	B	43	5
100	B	44	8
101	B	45	6
102	B	46	8
103	B	47	7
104	B	48	8
105	B	49	8
106	B	50	8
107	B	51	8
108	B	52	8
109	B	53	8
110	B	54	5
111	B	55	9
112	B	56	5
113	C	1	7
114	C	2	6
115	C	3	7
116	C	4	4

117	C	5	5
118	C	6	1
119	C	7	3
120	C	8	8
121	C	9	3
122	C	10	4
123	C	11	8
124	C	12	6
125	C	13	6
126	C	14	5
127	C	15	8
128	C	16	3
129	C	17	5
130	C	18	1
131	C	19	5
132	C	20	4
133	C	21	5
134	C	22	6
135	C	23	6
136	C	24	2
137	C	25	7
138	C	26	7
139	C	27	1
140	C	28	3
141	C	29	1
142	C	30	6
143	C	31	4
144	C	32	5
145	C	33	3
146	C	34	7
147	C	35	4
148	C	36	5
149	C	37	4
150	C	38	3
151	C	39	6
152	C	40	8
153	C	41	6
154	C	42	6
155	C	43	6
156	C	44	8
157	C	45	3
158	C	46	6
159	C	47	2
160	C	48	1

161	C	49	5
162	C	50	5
163	C	51	5
164	C	52	4
165	C	53	4
166	C	54	7
167	C	55	7
168	C	56	3
169	D	1	8
170	D	2	4
171	D	3	7
172	D	4	4
173	D	5	7
174	D	6	5
175	D	7	5
176	D	8	3
177	D	9	4
178	D	10	4
179	D	11	7
180	D	12	7
181	D	13	8
182	D	14	4
183	D	15	8
184	D	16	9
185	D	17	7
186	D	18	4
187	D	19	7
188	D	20	7
189	D	21	7
190	D	22	8
191	D	23	6
192	D	24	3
193	D	25	8
194	D	26	7
195	D	27	2
196	D	28	3
197	D	29	2
198	D	30	8
199	D	31	6
200	D	32	4
201	D	33	2
202	D	34	8
203	D	35	6
204	D	36	5

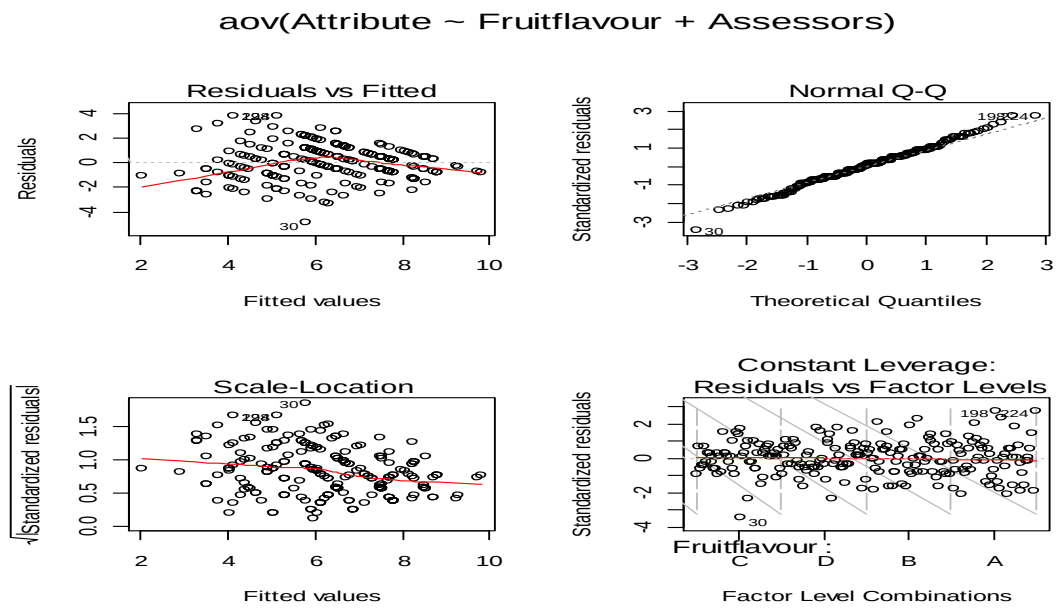
205	D	37	5
206	D	38	2
207	D	39	8
208	D	40	9
209	D	41	7
210	D	42	3
211	D	43	8
212	D	44	7
213	D	45	6
214	D	46	3
215	D	47	4
216	D	48	3
217	D	49	3
218	D	50	6
219	D	51	6
220	D	52	6
221	D	53	7
222	D	54	8
223	D	55	4
224	D	56	9

```
> library(asbio)
> tukey.add.test(results$Attribute,results$Fruitflavour,results$Assessors)

        Tukey's one df test for additivity

data:  results$Fruitflavour and results$Assessors on  results$Attribute
F = 11.6733, num.df = 1, denom.df = 164, p-value = 0.0007995

> preference.aov <- aov(Attribute~Fruitflavour+Assessors,results)
> summary(preference.aov)
                Df Sum Sq Mean Sq F value        Pr(>F)
Fruitflavour     3 252.79  84.262 31.7270 3.026e-16 ***
Assessors       55 240.93   4.381  1.6494    0.008386 **
Residuals      165 438.21   2.656
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
> oldpar <- par(oma=c(0,0,3,0), mfrow=c(2,2))
> plot(preference.aov)
```




```
>
Fruitflavour<-matrix(c(7,9,8,6,7,7,6,8,7,7,9,7,7,7,7,8,6,8,9,8,8,8,8,8,8,7,8,8,7,1,8,8,7,3,9,7,6,8,8,9,
9,8,5,7,7,8,7,7,7,8,8,8,8,6,9,6,7,9,9,8,7,7,7,7,8,8,9,7,6,6,6,7,6,6,9,7,7,7,7,9,8,8,8,6,4,4,9,9,8,3,7,8,
6,9,9,9,8,6,5,8,6,8,7,8,8,8,8,8,8,8,5,9,5,7,6,7,4,5,1,3,8,3,4,8,6,6,5,8,3,5,1,5,4,5,6,6,2,7,7,1,3,1,6,4,5,
3,7,4,5,4,3,6,8,6,6,6,8,3,6,2,1,5,5,5,4,4,7,7,3,8,4,7,4,7,5,5,3,4,4,7,7,8,4,8,9,7,4,7,7,7,8,6,3,8,7,2,3,
2,8,6,4,2,8,6,5,5,2,8,9,7,3,8,7,6,3,4,3,3,6,6,6,7,8,4,9),nrow = 56,byrow = FALSE,dimnames = list(1 :
56, c("A", "B", "C","D")))
> result <-friedman.test(Fruitflavour)
> result
```

Friedman rank sum test

data: Fruitflavour

Friedman chi-squared = 63.3459, df = 3, p-value = 1.133e-13

```
Ranktotals<-c(abs(colSums(Fruitflavour)[[1]]-colSums(Fruitflavour)[[2]]),
+ abs(colSums(Fruitflavour)[[1]]-colSums(Fruitflavour)[[3]]),
+ abs(colSums(Fruitflavour)[[1]]-colSums(Fruitflavour)[[4]]),
+ abs(colSums(Fruitflavour)[[2]]-colSums(Fruitflavour)[[3]]),
+ abs(colSums(Fruitflavour)[[2]]-colSums(Fruitflavour)[[4]]),
+ abs(colSums(Fruitflavour)[[3]]-colSums(Fruitflavour)[[4]]),
+ qtukey(0.95,9,999)*sqrt((56*4*(4+1))/12))
Comparisons <-c("A-B","A-C","A-D","B-C","B-D","C-D","critical distance for HSDRanks")
HSDRank.comparisons <- data.frame(Ranktotals, row.names=Comparisons)
HSDRank.comparisons
```

	Ranktotals
A-B	4.00000
A-C	140.00000

A-D	92.00000
B-C	136.00000
B-D	88.00000
C-D	48.00000
critical distance for HSDRanks	42.47132

Thickness

```
> Thickness.A
<-c(6,8,9,7,7,7,6,6,8,8,8,7,8,7,8,7,4,9,9,6,8,7,8,8,8,7,8,8,7,1,9,8,7,2,9,7,2,9,8,9,8,7,7,8,7,9,7,8,7,8,
7,7,5,6,8,7)
> Thickness.B
<-c(6,9,9,8,7,6,7,7,8,8,8,8,8,6,8,5,4,7,8,8,6,8,7,6,8,6,7,5,2,3,9,9,8,3,9,6,4,8,8,8,9,8,6,9,5,8,7,7,8,8,
8,6,8,3,8,6)
> Thickness.C
<-c(3,3,4,3,6,4,3,8,3,5,4,6,4,3,7,5,6,1,4,5,6,4,4,7,7,4,1,2,6,6,2,5,3,5,1,4,6,2,7,8,7,3,6,5,5,6,3,3,5,5,
5,3,2,8,7,4)
> Thickness.D
<-c(4,5,4,3,5,3,5,7,4,4,1,6,7,3,6,9,6,3,6,5,6,5,4,3,7,4,2,2,2,8,2,4,2,5,1,3,5,3,6,9,7,2,7,4,3,6,4,4,3,6,
5,6,2,8,5,4)
>
> Attribute <- c(Thickness.A,Thickness.B,Thickness.C,Thickness.D)
> Thickness.A <- rep("A", times=56)
> Thickness.B <- rep("B", times=56)
> Thickness.C <- rep("C", times=56)
> Thickness.D <- rep("D", times=56)
>
> Thickness<- factor(c(Thickness.A,Thickness.B,Thickness.C,Thickness.D))
> Assessors <- factor(rep(c(1:56), times=4))
> results <-
data.frame(Thickness=factor(Thickness),Assessors=factor(Assessors),Attribute=Attribute)
> results
```

	Thickness	Assessors	Attribute
1	A	1	6
2	A	2	8
3	A	3	9
4	A	4	7
5	A	5	7
6	A	6	7
7	A	7	6
8	A	8	6
9	A	9	8
10	A	10	8
11	A	11	8

12	A	12	7
13	A	13	8
14	A	14	7
15	A	15	8
16	A	16	7
17	A	17	4
18	A	18	9
19	A	19	9
20	A	20	6
21	A	21	8
22	A	22	7
23	A	23	8
24	A	24	8
25	A	25	8
26	A	26	7
27	A	27	8
28	A	28	8
29	A	29	7
30	A	30	1
31	A	31	9
32	A	32	8
33	A	33	7
34	A	34	2
35	A	35	9
36	A	36	7
37	A	37	2
38	A	38	9
39	A	39	8
40	A	40	9
41	A	41	8
42	A	42	7
43	A	43	7
44	A	44	8
45	A	45	7
46	A	46	9
47	A	47	7
48	A	48	8
49	A	49	7
50	A	50	8
51	A	51	7
52	A	52	7
53	A	53	5
54	A	54	6
55	A	55	8

56	A	56	7
57	B	1	6
58	B	2	9
59	B	3	9
60	B	4	8
61	B	5	7
62	B	6	6
63	B	7	7
64	B	8	7
65	B	9	8
66	B	10	8
67	B	11	8
68	B	12	8
69	B	13	8
70	B	14	6
71	B	15	8
72	B	16	5
73	B	17	4
74	B	18	7
75	B	19	8
76	B	20	8
77	B	21	6
78	B	22	8
79	B	23	7
80	B	24	6
81	B	25	8
82	B	26	6
83	B	27	7
84	B	28	5
85	B	29	2
86	B	30	3
87	B	31	9
88	B	32	9
89	B	33	8
90	B	34	3
91	B	35	9
92	B	36	6
93	B	37	4
94	B	38	8
95	B	39	8
96	B	40	8
97	B	41	9
98	B	42	8
99	B	43	6

100	B	44	9
101	B	45	5
102	B	46	8
103	B	47	7
104	B	48	7
105	B	49	8
106	B	50	8
107	B	51	8
108	B	52	6
109	B	53	8
110	B	54	3
111	B	55	8
112	B	56	6
113	C	1	3
114	C	2	3
115	C	3	4
116	C	4	3
117	C	5	6
118	C	6	4
119	C	7	3
120	C	8	8
121	C	9	3
122	C	10	5
123	C	11	4
124	C	12	6
125	C	13	4
126	C	14	3
127	C	15	7
128	C	16	5
129	C	17	6
130	C	18	1
131	C	19	4
132	C	20	5
133	C	21	6
134	C	22	4
135	C	23	4
136	C	24	7
137	C	25	7
138	C	26	4
139	C	27	1
140	C	28	2
141	C	29	6
142	C	30	6
143	C	31	2

144	C	32	5
145	C	33	3
146	C	34	5
147	C	35	1
148	C	36	4
149	C	37	6
150	C	38	2
151	C	39	7
152	C	40	8
153	C	41	7
154	C	42	3
155	C	43	6
156	C	44	5
157	C	45	5
158	C	46	6
159	C	47	3
160	C	48	3
161	C	49	5
162	C	50	5
163	C	51	5
164	C	52	3
165	C	53	2
166	C	54	8
167	C	55	7
168	C	56	4
169	D	1	4
170	D	2	5
171	D	3	4
172	D	4	3
173	D	5	5
174	D	6	3
175	D	7	5
176	D	8	7
177	D	9	4
178	D	10	4
179	D	11	1
180	D	12	6
181	D	13	7
182	D	14	3
183	D	15	6
184	D	16	9
185	D	17	6
186	D	18	3
187	D	19	6

188	D	20	5
189	D	21	6
190	D	22	5
191	D	23	4
192	D	24	3
193	D	25	7
194	D	26	4
195	D	27	2
196	D	28	2
197	D	29	2
198	D	30	8
199	D	31	2
200	D	32	4
201	D	33	2
202	D	34	5
203	D	35	1
204	D	36	3
205	D	37	5
206	D	38	3
207	D	39	6
208	D	40	9
209	D	41	7
210	D	42	2
211	D	43	7
212	D	44	4
213	D	45	3
214	D	46	6
215	D	47	4
216	D	48	4
217	D	49	3
218	D	50	6
219	D	51	5
220	D	52	6
221	D	53	2
222	D	54	8
223	D	55	5
224	D	56	4

>

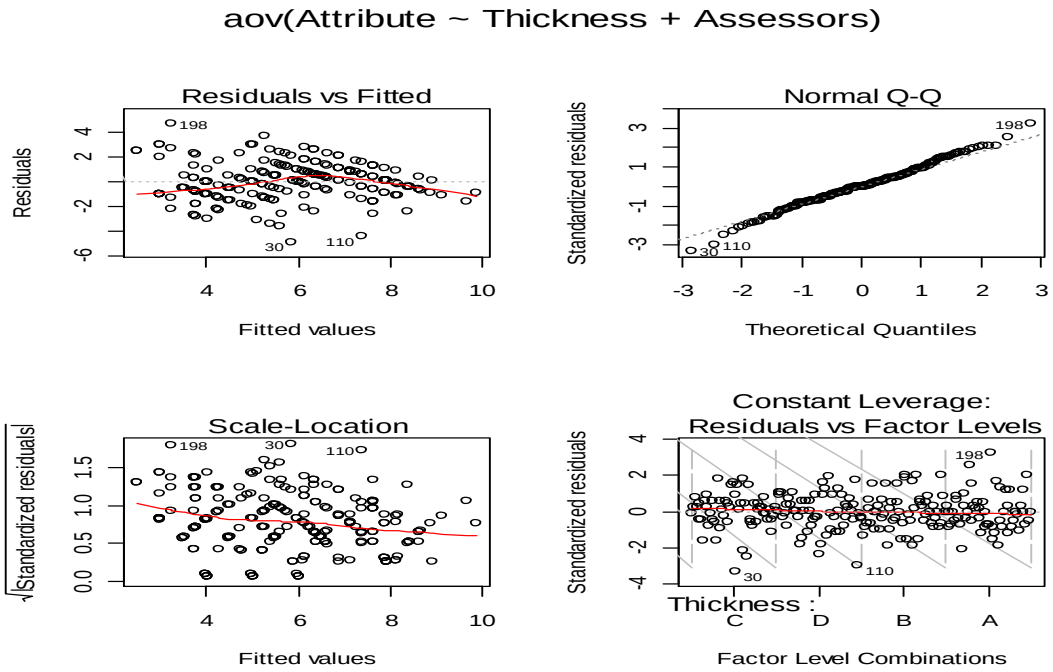
```
> library(asbio)
> tukey.add.test(results$Attribute,results$Thickness,results$Assessors)

        Tukey's one df test for additivity

data:  results$Thickness and results$Assessors on  results$Attribute
```

F = 1.8248, num.df = 1, denom.df = 164, p-value = 0.1786

```
> preference.aov <- aov(Attribute~Thickness+Assessors,results)
> summary(preference.aov)
             Df Sum Sq Mean Sq F value     Pr(>F)
Thickness     3 353.80 117.933  40.375 < 2e-16 ***
Assessors    55 230.21   4.186   1.433 0.04336 *
Residuals   165 481.95   2.921
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> oldpar <- par(oma=c(0,0,3,0), mfrow=c(2,2))
> plot(preference.aov)
```




```
TukeyHSD(preference.aov,"Thickness",conf.level=0.99)

  Tukey multiple comparisons of means
    99% family-wise confidence level

Fit: aov(formula = Attribute ~ Thickness + Assessors, data = results)

$Thickness
            diff        lwr        upr     p adj
B-A -0.21428571 -1.235395  0.8068239 0.9106447
C-A -2.62500000 -3.646110 -1.6038904 0.0000000
D-A -2.60714286 -3.628252 -1.5860333 0.0000000
C-B -2.41071429 -3.431824 -1.3896047 0.0000000
D-B -2.39285714 -3.413967 -1.3717476 0.0000000
```

D-C 0.01785714 -1.003252 1.0389667 0.9999391

Overall Acceptability

```
> Overall.A
<-c(5,8,8,7,8,7,6,7,6,7,8,6,7,7,7,7,6,9,9,8,8,8,8,9,8,6,6,8,8,2,9,8,7,2,9,7,2,8,8,9,9,8,6,8,7,9,7,8,8,8,
7,7,6,6,9,7)
> Overall.B
<-c(6,9,9,8,7,7,7,7,9,8,7,6,7,6,7,5,6,7,8,8,7,7,7,9,8,8,7,6,4,3,9,9,8,3,9,7,5,9,9,9,8,7,5,8,6,9,8,8,8,8,
8,7,8,3,8,5)
> Overall.C
<-c(4,5,6,3,6,2,2,6,4,4,6,6,6,4,8,4,6,1,5,5,4,6,6,2,7,6,1,4,2,6,3,5,3,6,3,4,5,4,7,8,6,6,6,7,4,6,3,1,6,5,
6,3,3,7,8,4)
> Overall.D
<-c(8,4,7,4,6,4,5,4,4,5,4,7,8,4,8,9,7,3,8,7,7,7,6,4,8,6,2,4,1,8,3,4,2,7,5,3,4,3,7,9,7,3,7,8,4,5,5,2,3,7,
6,4,5,8,5,8)
> Attribute <- c(Overall.A,Overall.B,Overall.C,Overall.D)
> Overall.A <- rep("A", times=56)
> Overall.B <- rep("B", times=56)
> Overall.C <- rep("C", times=56)
> Overall.D <- rep("D", times=56)
> Overall<- factor(c(Overall.A,Overall.B,Overall.C,Overall.D))
> Assessors <- factor(rep(c(1:56), times=4))
> results <- data.frame(Overall=factor(Overall),Assessors=factor(Assessors),Attribute=Attribute)
> results
```

	Overall	Assessors	Attribute
1	A	1	5
2	A	2	8
3	A	3	8
4	A	4	7
5	A	5	8
6	A	6	7
7	A	7	6
8	A	8	7
9	A	9	6
10	A	10	7
11	A	11	8
12	A	12	6
13	A	13	7
14	A	14	7
15	A	15	7
16	A	16	7
17	A	17	6
18	A	18	9

19	A	19	9
20	A	20	8
21	A	21	8
22	A	22	8
23	A	23	8
24	A	24	9
25	A	25	8
26	A	26	6
27	A	27	6
28	A	28	8
29	A	29	8
30	A	30	2
31	A	31	9
32	A	32	8
33	A	33	7
34	A	34	2
35	A	35	9
36	A	36	7
37	A	37	2
38	A	38	8
39	A	39	8
40	A	40	9
41	A	41	9
42	A	42	8
43	A	43	6
44	A	44	8
45	A	45	7
46	A	46	9
47	A	47	7
48	A	48	8
49	A	49	8
50	A	50	8
51	A	51	7
52	A	52	7
53	A	53	6
54	A	54	6
55	A	55	9
56	A	56	7
57	B	1	6
58	B	2	9
59	B	3	9
60	B	4	8
61	B	5	7
62	B	6	7

63	B	7	7
64	B	8	7
65	B	9	9
66	B	10	8
67	B	11	7
68	B	12	6
69	B	13	7
70	B	14	6
71	B	15	7
72	B	16	5
73	B	17	6
74	B	18	7
75	B	19	8
76	B	20	8
77	B	21	7
78	B	22	7
79	B	23	7
80	B	24	9
81	B	25	8
82	B	26	8
83	B	27	7
84	B	28	6
85	B	29	4
86	B	30	3
87	B	31	9
88	B	32	9
89	B	33	8
90	B	34	3
91	B	35	9
92	B	36	7
93	B	37	5
94	B	38	9
95	B	39	9
96	B	40	9
97	B	41	8
98	B	42	7
99	B	43	5
100	B	44	8
101	B	45	6
102	B	46	9
103	B	47	8
104	B	48	8
105	B	49	8
106	B	50	8

107	B	51	8
108	B	52	7
109	B	53	8
110	B	54	3
111	B	55	8
112	B	56	5
113	C	1	4
114	C	2	5
115	C	3	6
116	C	4	3
117	C	5	6
118	C	6	2
119	C	7	2
120	C	8	6
121	C	9	4
122	C	10	4
123	C	11	6
124	C	12	6
125	C	13	6
126	C	14	4
127	C	15	8
128	C	16	4
129	C	17	6
130	C	18	1
131	C	19	5
132	C	20	5
133	C	21	4
134	C	22	6
135	C	23	6
136	C	24	2
137	C	25	7
138	C	26	6
139	C	27	1
140	C	28	4
141	C	29	2
142	C	30	6
143	C	31	3
144	C	32	5
145	C	33	3
146	C	34	6
147	C	35	3
148	C	36	4
149	C	37	5
150	C	38	4

151	C	39	7
152	C	40	8
153	C	41	6
154	C	42	6
155	C	43	6
156	C	44	7
157	C	45	4
158	C	46	6
159	C	47	3
160	C	48	1
161	C	49	6
162	C	50	5
163	C	51	6
164	C	52	3
165	C	53	3
166	C	54	7
167	C	55	8
168	C	56	4
169	D	1	8
170	D	2	4
171	D	3	7
172	D	4	4
173	D	5	6
174	D	6	4
175	D	7	5
176	D	8	4
177	D	9	4
178	D	10	5
179	D	11	4
180	D	12	7
181	D	13	8
182	D	14	4
183	D	15	8
184	D	16	9
185	D	17	7
186	D	18	3
187	D	19	8
188	D	20	7
189	D	21	7
190	D	22	7
191	D	23	6
192	D	24	4
193	D	25	8
194	D	26	6

195	D	27	2
196	D	28	4
197	D	29	1
198	D	30	8
199	D	31	3
200	D	32	4
201	D	33	2
202	D	34	7
203	D	35	5
204	D	36	3
205	D	37	4
206	D	38	3
207	D	39	7
208	D	40	9
209	D	41	7
210	D	42	3
211	D	43	7
212	D	44	8
213	D	45	4
214	D	46	5
215	D	47	5
216	D	48	2
217	D	49	3
218	D	50	7
219	D	51	6
220	D	52	4
221	D	53	5
222	D	54	8
223	D	55	5
224	D	56	8

>

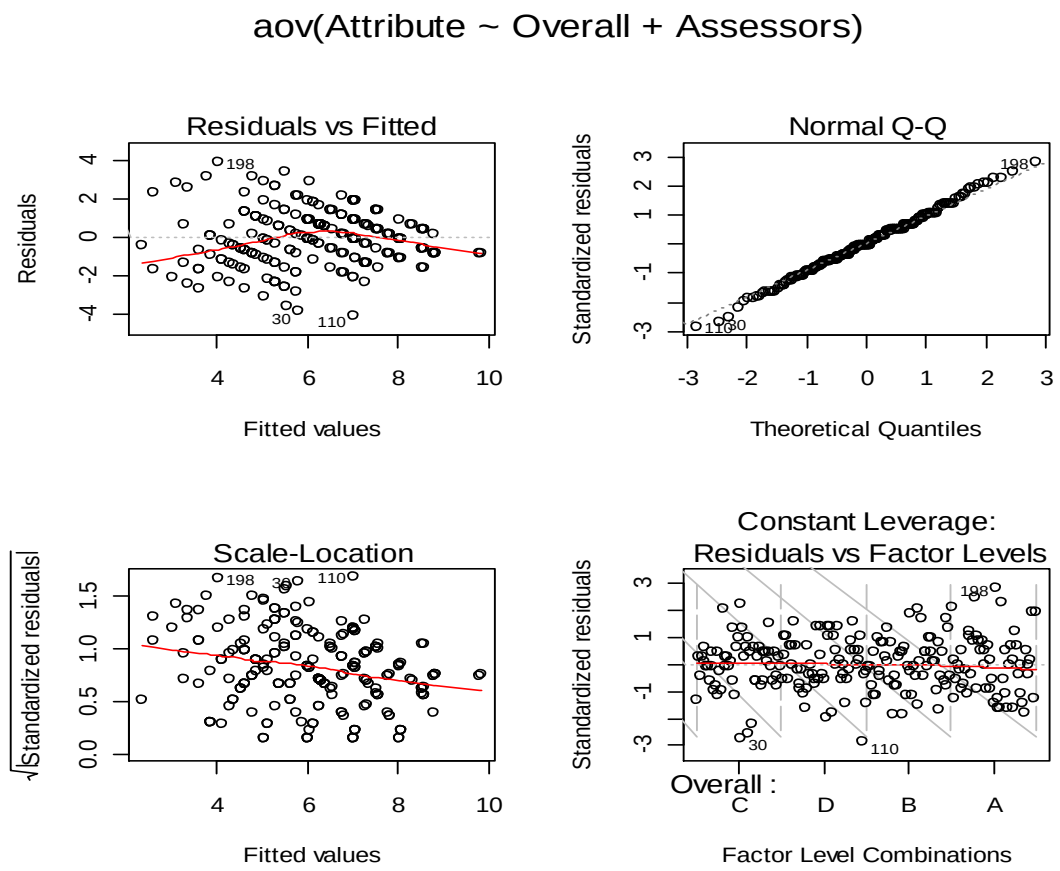
```
> library(asbio)
> tukey.add.test(results$Attribute,results$Overall,results$Assessors)
        Tukey's one df test for additivity

data:  results$Overall and results$Assessors on  results$Attribute
F = 3.7331, num.df = 1, denom.df = 164, p-value = 0.05507

> preference.aov <- aov(Attribute~Overall+Assessors,results)
> summary(preference.aov)
             Df Sum Sq Mean Sq F value     Pr(>F)
Overall       3 258.80  86.266 32.0259 2.285e-16 ***
Assessors    55 246.00   4.473  1.6604  0.007671 **
Residuals   165 444.45   2.694
```

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

```
> oldpar <- par(oma=c(0,0,3,0), mfrow=c(2,2))
> plot(preference.aov)
```




```
TukeyHSD(preference.aov,"Overall",conf.level=0.99)
```

Tukey multiple comparisons of means
99% family-wise confidence level

Fit: aov(formula = Attribute ~ Overall + Assessors, data = results)

$Overall

	diff	lwr	upr	p adj
B-A	-0.03571429	-1.0162939	0.9448653	0.9994519
C-A	-2.44642857	-3.4270081	-1.4658490	0.0000000
D-A	-1.78571429	-2.7662939	-0.8051347	0.0000002
C-B	-2.41071429	-3.3912939	-1.4301347	0.0000000
D-B	-1.75000000	-2.7305796	-0.7694204	0.0000004
D-C	0.66071429	-0.3198653	1.6412939	0.1478626